Recent Research Activities of TP2: Field Testing and Monitoring

Andrew C. Stolte *[1, 2], **Liam M. Wotherspoon** [1, 3], **Seokho Jeong** [1, 4], **Quincy Ma** [1, 3], and **Geoff W. Rodgers** [1, 2]

[1] QuakeCoRE, [2] University of Canterbury, [3] University of Auckland, [4] University of Waikato

*andrew.stolte@canterbury.ac.nz

QuakeCoRE
NZ Centre for Earthquake Resilience
Te Hiranga Rū

Summary

QuakeCoRE Technology Platform 2 (TP2) has worked to build upon existing Aotearoa New Zealand leadership in field testing and monitoring. Key thrust areas of this platform include:

- Training of personnel on state-of-the-art field testing and monitoring techniques and equipment.
- Development of standardised guidelines for field data acquisition and processing.
- Implementation of equipment for long-term field monitoring studies.
- Development of advanced field testing and monitoring techniques that push beyond current practice.

In support of these objectives, QuakeCoRE TP2 has either directly led or supported research activities across Aotearoa New Zealand.

Geotechnical Site Characterisation

TP2 is currently characterising soils and refining sedimentary basin models throughout Aotearoa New Zealand (Figure 1). These basin models enable a better understanding of the effect of local site conditions on earthquake shaking and improve regional site characterisation for seismic design.

Specifically, two testing methods have been used to characterise these deep sedimentary basins:

- The Horizontal-to-Vertical Spectral Ratio (HVSR or H/V) to evaluate site period and estimate depth to bedrock.
- Surface wave testing methods to evaluate soil stiffness profiles (e.g., shear wave velocity).

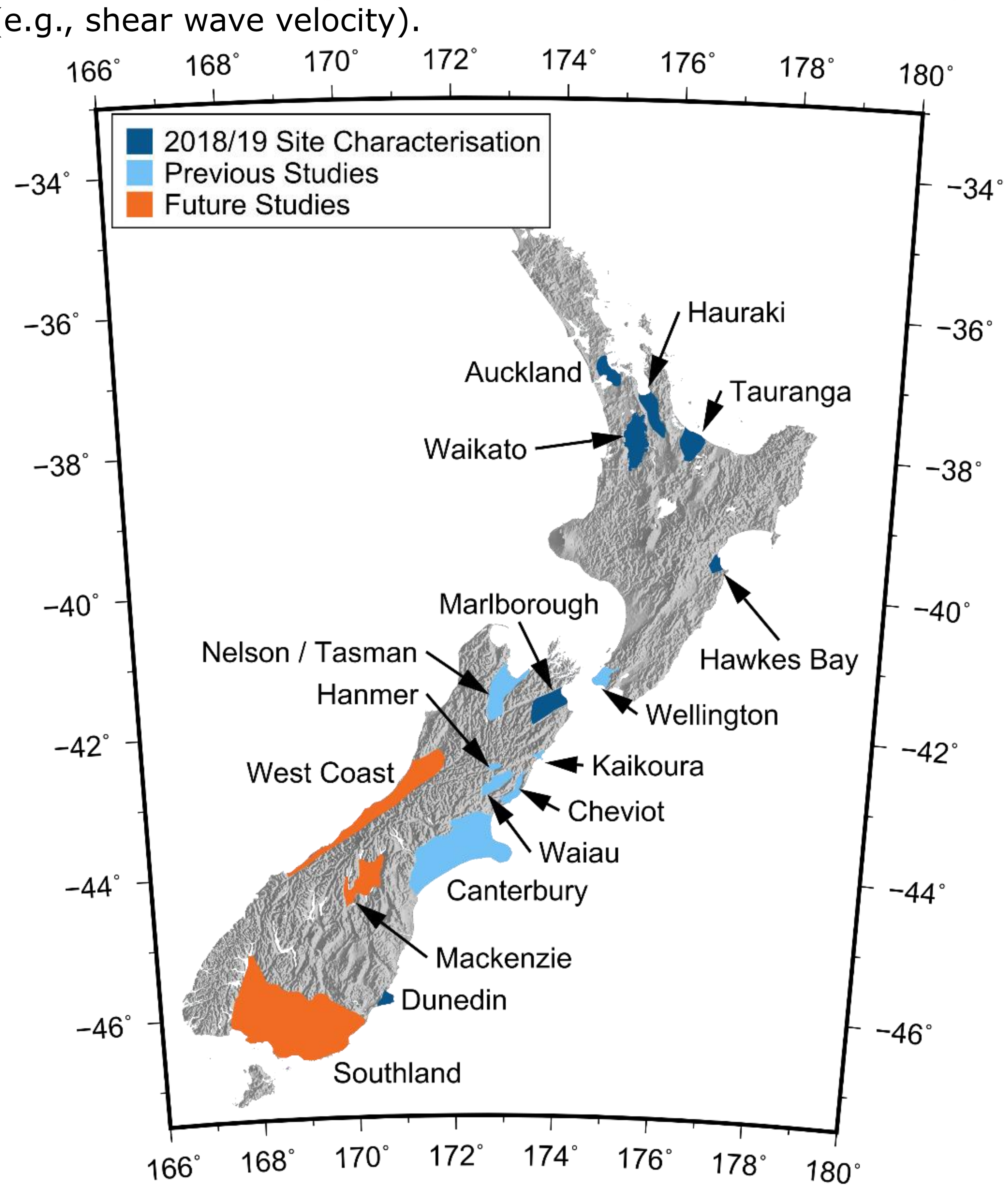

Figure 1: Map of NZ sedimentary basins recently targeted by TP2 for field testing.

Hawkes Bay, a region with high levels of anticipated ground shaking, was one of the basins characterized. H/V testing was conducted at 120+ sites to develop a map of site period (Figure 2), providing insight into the depth of the basin across the region. Additionally, the shear stiffness of these sediments, as indicated by the Vs profiles in Figure 3, was characterized using surface wave testing methods.

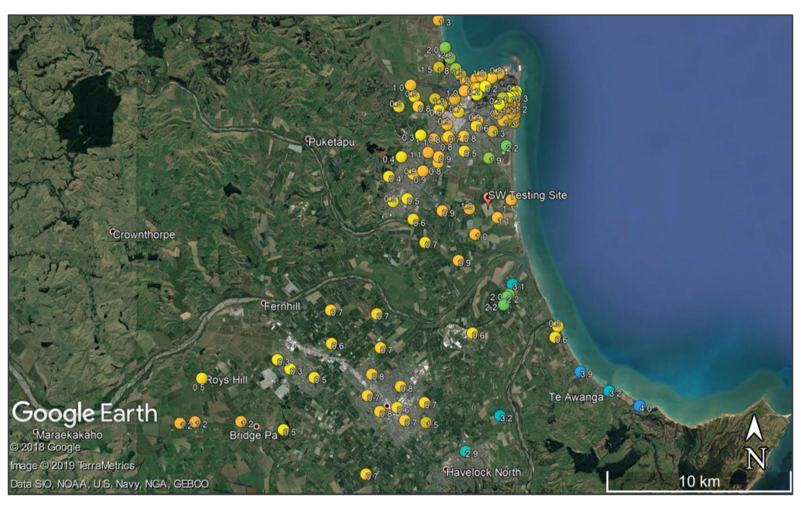

Figure 2: Map of site period in Hawkes Bay. As site period (and basin depth) increases, the colour of the site markers transitions from yellow to blue.

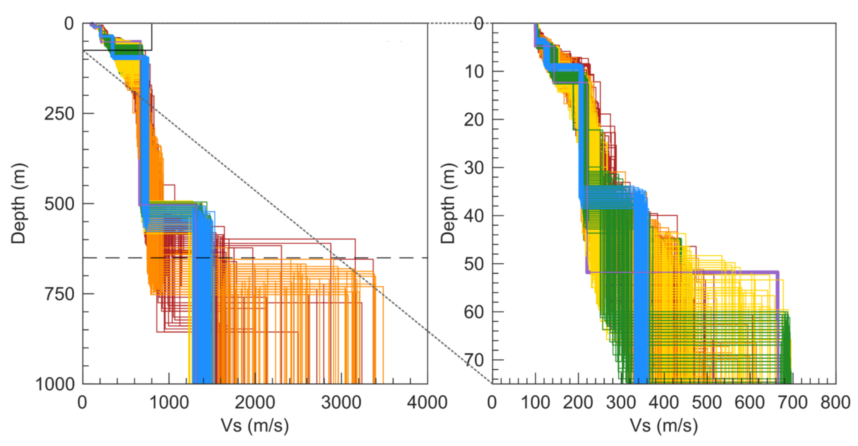

Figure 3: Shear wave velocity (V_S) profiles from surface wave testing at a site near Napier.

Structural Monitoring

The Awatere Bridge near Seddon is one of four bridges in Aotearoa New Zealand that has been instrumented with cellular-networked accelerometers (Figure 4) for real-time monitoring of the bridge. This allows researchers to study the dynamic response of the bridge and improve structural models. Example acceleration records from the 2018 M6.2 Taumarunui Earthquake are shown in Figure 5.

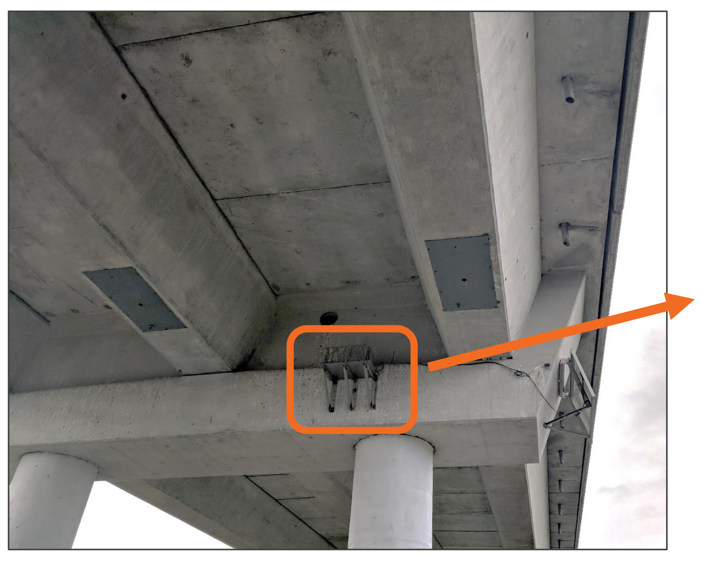

Figure 4: Accelerometer placed at the south quarter span on the Awatere Bridge.

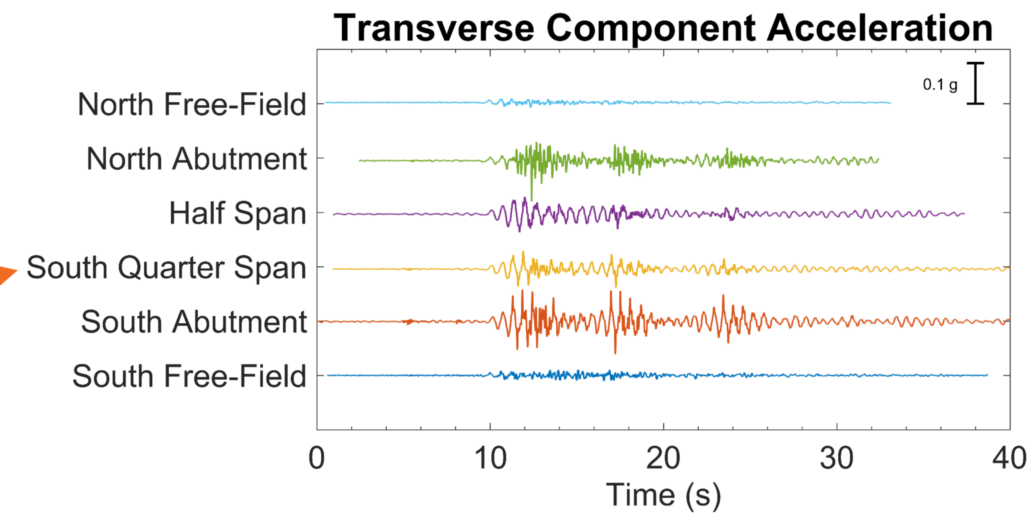

Figure 5: Awatere Bridge transverse acceleration records of the 2018 M6.2 Taumarunui earthquake

Low-cost Instrumentation

TP2 has continued to support the development of field testing and monitoring capabilities trough the implementation of low-cost instrumentation, including the use of accelerometers for structural monitoring and experimentation with low-cost alternatives to seismometers. A typical broadband seismometer may cost more than $30,000 NZD. For comparison, a Raspberry Shake 3D (Figure 6) costs less than $2,000 NZD. An example ground motion recorded using a Raspberry Shake 3D is shown in Figure 7.

Figure 6: Raspberry Shake 3D, a low-cost, geophone and Raspberry Pi based seismograph.

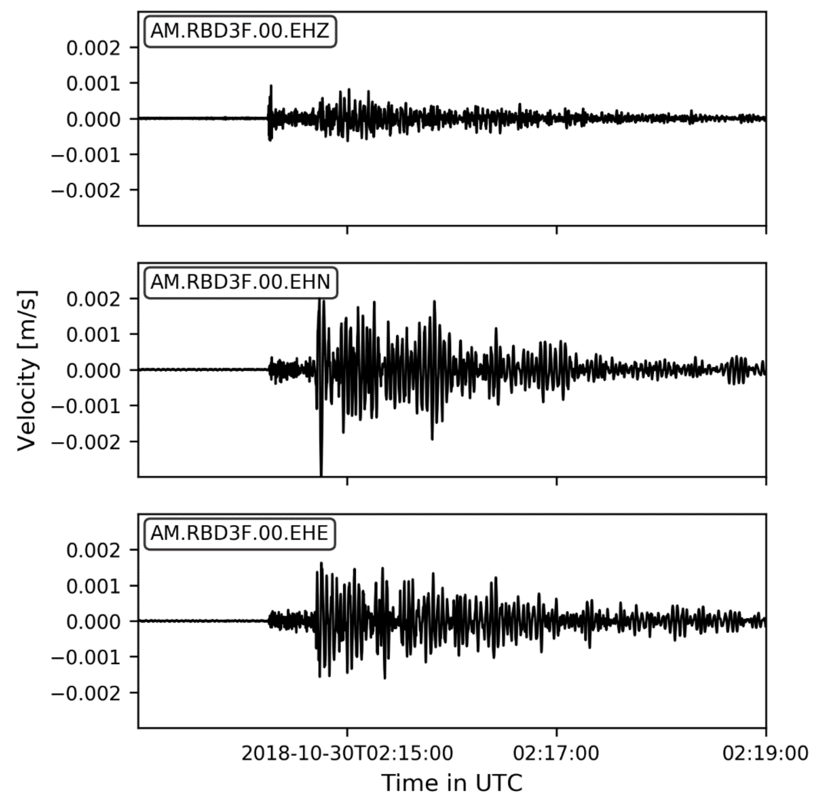

Figure 7: A ground motion from the 2018 M6.2 Taumarunui earthquake recorded using a Raspberry Shake 3D at the University of Waikato.

Field Testing Guidelines and Training

Leveraging TP2 experience in field testing and monitoring, best-practice field testing procedures and guidelines (Figure 8) have been developed for use by researchers and engineering practitioners. These guidelines are available on the QuakeCoRE wiki. Furthermore, the TP2 team has organized training courses, including a joint TP1 and TP2 experimental methods workshop (Figure 9) and a short course for industry on best practice site investigation and characterisation.

Figure 8 (Left): Sample TP2 field testing procedures and data analysis guidelines

Figure 9 (Above): Lucas Hogan (TP1) presenting at the joint TP1 and TP2 experimental methods workshop session at the University of Canterbury